

AMENDMENTS TO THE DRAWINGS

The attached sheet of drawings includes changes to Figure 3. This sheet, which includes Figures 2-3, replaces the original sheets including Figures 2-3.

Figure 3 has been amended to include labels for feed lines 33b and 33c as required by the Examiner. No new matter has been added.

Attachments: Replacement sheet
Annotated sheet showing changes

REMARKS

This is intended as a full and complete response to the Office Action dated January 9, 2008, having a shortened statutory period for response set to expire on April 9, 2008. Please reconsider the claims pending in the application for reasons discussed below.

Claims 1-30 are pending in the application and are shown above. Claims 1 and 14 have been amended to clarify the invention. Claims 25-30 are withdrawn from consideration. Claim 10 has been amended to correct informalities. Claims 1-24 are rejected by the Examiner. Reconsideration of the rejected claims is requested for reasons presented below.

In the Specification, paragraph [0045] has been amended to correct a typographical error in response to the Examiner's objection.

In the Drawings, Figure 3 has been amended to include labels for feed lines 33b and 33c. No new matter has been added.

Restrictions/Election Requirement

Claims 1-30 are subject to the following election/restriction requirement under 35 U.S.C. § 121:

- I. Claims 1-24, drawn to a process for depositing metal film, classified in class 427, subclass 248.1.
- II. Claims 25-30, drawn to a system for depositing a metal film, classified in class 118, subclass 715.

Applicant elected Group I, claims 1-24, with traverse during a telephone conversation with the examiner on December 12, 2007. Applicant hereby confirms such election. Applicant submits that the two claim groups are drawn to a system for depositing a metal film and a process using the system. Applicant further submits that a prior art search that identifies references relevant to one claim group would identify references relevant to the other claim group. Thus, examining all the claims together would not pose an undue burden on the Examiner. Applicant respectfully requests withdrawal of the restriction requirement.

Rejections under 35 U.S.C. § 112

Claims 1 and 10 are rejected under 35 U.S.C. § 112 as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. The Examiner asserts that the term "rapidly" in claim 1, which is not defined in the claim or in the specification, is a relative term, would not reasonably apprise one of ordinary skill in the art of the scope of the invention in claim 1, and is therefore indefinite. The Examiner also asserts that the limitation "said first pressurization...and said second pressurization" in lines 2 and 3 of claim 10 lack antecedent basis.

Applicant has amended claims 1 and 14 to clarify the invention. Support for the amendments can be found at least in paragraph [0045] of the specification. Applicant has amended claim 10 to provide antecedent basis. Applicant submits that no new matter is added by these amendments.

Applicant submits that the claims as amended are in proper form. Withdrawal of the rejection is respectfully requested.

Rejections under 35 U.S.C. § 102

Claims 1, 4, 6, 9, and 14 are rejected under 35 U.S.C. § 102(b) as being anticipated by *Meng Chu Tseng, et al.* (European Patent No. 0704551, hereinafter "Tseng"). The Examiner asserts that Tseng teaches a method of processing a substrate in a vacuum processing chamber comprising heating the substrate, providing a process gas consisting of WF_6 and dichlorosilane to the chamber, subsequently removing the process gas from the chamber in a purge step, introducing argon gas at a lower pressure than the initial pressure to purge the chamber, and depositing a bulk metal layer. Applicant respectfully traverses the rejection.

Tseng discloses a process for the deposition of tungsten silicide (WSi_x) from tungsten hexafluoride (WF_6) and dichlorosilane (SiH_2Cl_2) (col. 1, lines 1-6). The process of Tseng includes depositing WSi_x on a substrate from a mixture of WF_6 , SiH_2Cl_2 , and argon (col. 5, lines 57-59), an optional silane soak step prior to deposition (col. 8, lines 37-40), an optional SiH_2Cl_2 purge step after deposition (col. 7, lines 12-14), a silane purge step after

deposition (col. 7, lines 28-30), and then removing the substrate from the deposition chamber (col. 8, lines 26-28). Tseng does not disclose nucleating the substrate with a metal, as claimed in claims 1 and 14, and claims dependent thereon. A metal is an element, or a mixture or alloy of elements. Chemical compounds such as WSi_x are not metals. In particular, WSi_x is a ceramic. Thus, the process disclosed by Tseng deposits a ceramic, not a metal. Moreover, Tseng does not disclose a process of nucleating the substrate. Tseng rather deposits a bulk layer on the substrate, as the Examiner observes in Example 1, proceeding thereafter to evaluate the sheet resistance and residual stress in the layer. Finally, Tseng does not disclose controlling production of a concentration boundary as part of the process.

Thus, Tseng does not teach, show, suggest, or make obvious a process for depositing a metal film on a substrate disposed in a processing chamber, said process comprising heating said substrate; and introducing into, and removing from, said processing chamber, a process gas consisting of a metal source and a hydrogen source to nucleate said substrate with metal while controlling production of a concentration boundary layer by removing said process gas from said processing chamber after commencement of nucleation of said substrate, wherein removing said process gas from said processing chamber lasts from about 3 to about 12 seconds, as recited by amended claim 1 and claims dependent thereon.

Furthermore, Tseng does not teach, show, suggest, or make obvious a process for depositing a metal film on a substrate disposed in a processing chamber, said process comprising heating said substrate; and introducing into, and removing from, said processing chamber, a process gas consisting of a tungsten source and a hydrogen source to nucleate said substrate with tungsten by removing said process gas from said processing chamber after commencement of nucleation of said substrate with tungsten, wherein removing said process gas from said processing chamber lasts from about 3 to about 12 seconds, as recited by amended claim 14 and claims dependent thereon.

Applicant respectfully requests the rejection be withdrawn.

Rejections under 35 U.S.C. § 103

Claims 3, 12, and 13 are rejected under 35 U.S.C. § 103(a) as being obvious over Tseng. The Examiner asserts that Tseng teaches an exhaust system equipped with a throttle valve that can regulate chamber pressure, a first pressure level of 2 torr during the conditioning/soak step, and introduction of process gases and purging of the chamber bottom with argon while the chamber is at a pressure of 0.8 torr. The Examiner acknowledges that Tseng does not disclose the pressure upon introduction of the process gas, but asserts that from the teachings of Tseng it would be obvious to one of ordinary skill in the art to practice the process of claim 1 with the higher and lower pressure limitations of claims 3, 12, and 13. Applicant respectfully traverses the rejection.

Tseng is discussed above. Because Tseng does not teach, show, suggest, or make obvious the invention recited by claims 3, 12, and 13, depending from amended claim 1, Applicant respectfully requests the rejection be withdrawn.

Claim 11 is rejected under 35 U.S.C. § 103(a) as being obvious over Tseng in view of Lee (U.S. Patent No. 5,455,069, hereinafter "Lee"). The Examiner asserts that Tseng teaches using WF_6 and SiH_2Cl_2 , but acknowledges that Tseng does not disclose using silane, molecular hydrogen, or diborane for depositing a layer. The Examiner asserts, however, that Lee teaches use of SiH_2Cl_2 interchangeably with silane in a method of improving layer uniformity, and that these two gases are art-recognized equivalents. The Examiner thus concludes that one of ordinary skill in the art would have found it obvious to substitute Lee's silane for Tseng's SiH_2Cl_2 to coat the substrate with a tungsten containing layer. Applicant respectfully traverses the rejection.

Tseng is discussed substantially above. Lee teaches a method of improving layer uniformity in a CVD reactor by providing a susceptor with a curved edge, and by rotating the substrate. In particular, Lee discloses that silane may be used interchangeably with SiH_2Cl_2 for depositing epitaxial silicon layers (col. 3 lines 17-20). Lee does not remedy the deficiency of Tseng, and does not discuss the different chemistry of depositing metal layers. Moreover, Tseng teaches that the process of Tseng utilizing SiH_2Cl_2 is superior to an equivalent process using silane (col. 1, lines 47-54).

Therefore, Tseng and Lee, alone or in combination, do not teach, show, suggest, or make obvious the invention recited by claim 11. Applicant respectfully requests the rejection be withdrawn.

Claims 2, 7, 8, 10, 15, and 16 are rejected under 35 U.S.C. § 103(a) as being obvious over Tseng in view of *Emesh* (U.S. Patent No. 5,407,698, hereinafter "Emesh"). The Examiner acknowledges that Tseng does not disclose repeating a nucleation cycle multiple times while varying the metal/hydrogen ratio, time intervals for nucleation steps or introducing and terminating the processing gas, or specific pressure ranges. The Examiner asserts, however, that Emesh discloses a method for low pressure chemical deposition of tungsten that entails depositing a first layer of tungsten with a H_2/WF_6 ratio of 6, followed by a second layer with a H_2/WF_6 ratio of 20, and that this renders the claimed invention obvious to one of ordinary skill in the art at the time of the invention. The Examiner also asserts that times and pressures are determined by the desired qualities of the deposited film, and a practitioner of ordinary skill would find it obvious to determine the required times and values to produce the desired qualities. Applicant respectfully traverses the rejection.

Tseng is discussed above. Emesh discloses a method of tungsten deposition and metallization including deposition of a tungsten nucleation layer at a first set of precursor flow rates and process conditions (col. 5, line 65 – col. 6, line 8), deposition of a first thickness of tungsten at a second set of precursor flow rates and process conditions (col. 6, lines 16-22), and deposition of a second thickness of tungsten at a third set of precursor flow rates and process conditions (col. 6, lines 28-34), the stages being designed to influence the structure and characteristics of the resulting tungsten layer (col. 6, lines 47-48), such as reflectivity, film stress, and surface roughness (col. 6 line 63 – col. 7 line 6). Emesh does not disclose introducing and removing process gas multiple times to nucleate a substrate with metal. Moreover, there is no motivation to adapt the disclosure of Emesh to the process of Tseng to produce the claimed invention.

Therefore, Tseng and Lee, alone or in combination, do not teach, show, suggest, or make obvious the invention recited by claims 2, 7, 8, 10, 15, and 16. Applicant respectfully requests the rejection be withdrawn.

Claims 17-21, 23, and 24 are rejected under 35 U.S.C. § 103(a) as being obvious over Tseng in view of Emesh and further in view of Lee. The Examiner applies the references to the limitations of these claims in ways similar to the foregoing rejections. Applicant, having discussed these references in relation to the claim limitations above, submits that Tseng, Emesh, and Lee, alone or in combination, do not teach, show, suggest, or make obvious the invention recited by claims 17-21, 23, and 24. Applicant therefore respectfully requests the rejection be withdrawn.

Claim 22 is rejected under 35 U.S.C. § 103(a) as being obvious over Tseng in view of Emesh, Lee, and further in view of *Rajagopalan, et al.* (U.S. Patent No. 6,156,382, hereinafter "Rajagopalan"). The Examiner acknowledges that Tseng does not teach maintaining a constant pressure, invoking Rajagopalan to supply the necessary teaching. Applicant respectfully traverses the rejection.

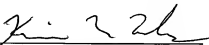
Tseng, Emesh, and Lee are discussed above. Rajagopalan discloses a process for depositing tungsten films on a substrate including a diborane presoak step between a nucleation step and a deposition step (col. 7, lines 48-50). Rajagopalan also discloses a method of controlling the process. Rajagopalan does not remedy all the enumerated deficiencies of Tseng, Emesh, and Lee.

Therefore, Tseng, Emesh, Lee, and Rajagopalan, alone or in combination, do not teach, show, suggest, or make obvious the invention recited in claim 22. Applicant respectfully requests the rejection be withdrawn.

In conclusion, the references cited by the Examiner, alone or in combination, do not teach, show, or suggest the invention as claimed.

Having addressed all issues set out in the Office Action, Applicant respectfully submits that the claims are in condition for allowance and respectfully request that the claims be allowed.

Respectfully submitted,

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ANNOTATED SHEET

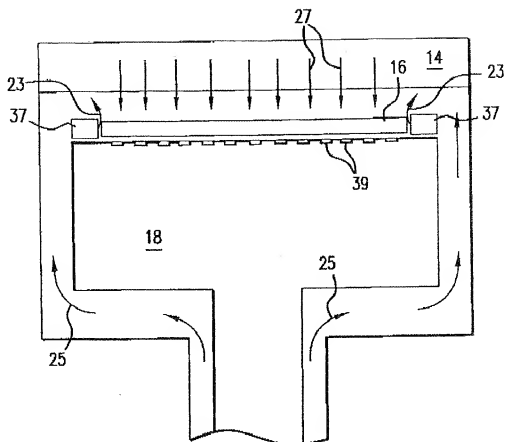


FIG. 2

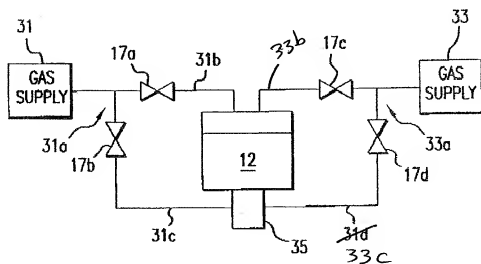


FIG. 3